CRISP NEWS

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Editorial

One of the strengths of CRISP is that the source code has effectively been in the public domain since it was released in the early 1980s. This, together with a text book explaining the "hows and whys", has enabled users to see for themselves exactly what is going on inside the program. This flies in the face of normal commercial practice, and has not been universally acclaimed as the right way to do things, but it has meant that genuine "glass box" testing and validation is possible. The establishment of the CRISP Consortium will help guarantee the continuation of this open policy, whilst ensuring that CRISP remains at the forefront of the geotechnical finite element market. Please don't neglect to use this forum to express your views on the future of CRISP, and the developments which you would like to see take place.

This issue of CRISP News sees the continuation of our series of technical articles - this time with the bending moment options in SAGE CRISP under the microscope. We also have the first in a new series of articles describing how different groups are using CRISP to tackle a range of engineering problems. I would be pleased to hear from any other company or university department who would like to have their use of CRISP profiled in a similar manner.

Rick Woods
University of Surrey

New Web Site Address

SAGE CRISP has a new, easy to remember, web site address:- **www.sage-uk.com**. This is not to be confused with the CRISP Consortium web page www.CRISPConsortium.com.

SAGE's web site contains up to date information on SAGE CRISP, publications listing, hints and tips, technical support questions, free download utilities and is FREE to use.

10th CRISP User Group Meeting

The 10th CRISP Users Group Meeting will be held at City University, London on **Friday 26th September**. This one day meeting is aimed at former, current or potential users of **any** version of the program.

To mark the 10th anniversary of CRISP User Group Meetings, new innovations will be introduced in addition to the traditional format, comprising short presentations of recent work. These innovations will allow delegates to contribute to discussion sessions on three main themes; soil-structure interaction, 3-dimensional problems and modelling the soil. There will also be a technical question and answer session with a panel of experts. The discussion sessions will be introduced by Professors Ian Pyrah, William Powrie, and Neil Taylor, and in the spirit of previous meetings we hope to promote a lively and informal debate.

To cover the cost of lunch and printing of notes, there is a registration fee of £30. Time is running out so please send in your registration form soon - or contact: Dr Sarah Stallebrass, UK Tel: 0171 477 8147, e-mail: s.e.stallebrass@city.ac.uk

Don't Delay - Register Today

Need advice on CRISP? Then join us on the NET

Over the past year the CRISP Users discussion list has enabled any user of CRISP to draw on the combined expertise and knowledge of specialists around the world. The list has also been employed to keep users up to date on development proposals and other related matters.

The list was the ideal medium for a recent "discussion" on what users wanted in the next release, and has proved an invaluable asset to the CRISP community. If you have missed all of this, then join now - joining could not be simpler. Just send the following e-mail to Mailbase @mailbase.ac.uk:

JOIN CRISP-users Firstname Lastname
STOP

Once you have joined, you will receive information on how to use the service. Thereafter you will be kept up to date with what is happening, and will have the opportunity to pose your own questions. The service is free and (at present) open to all.

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Bending CRISP

Amir Rahim and Mike Gunn explain some of the mystery behind the bending moments options in CRISP

It is possible to obtain bending moments from 2D linear strain quadrilateral elements and beam elements in the SAGE-CRISP 3.02 post-processor. For beam elements the constitutive relationship is formulated according to thick beam theory. See Hinton and Owen (1977) [1]. This takes into account the extra deformation due to the transverse shear along the beam. The post-processor displays the results from CRISP without further calculation. For 2D elements, however, the journey to bending moments starts at the stresses...   For a plane strain quadrilateral element representing part of a structure, the bending moment about section x-x in Figure 1 is found from the integral:

$$M_{xx} = \int_{-h/2}^{h/2} \sigma_x \, y.dy$$

Where h is the depth of the beam and σ_x is the stress normal to the cross section. The SAGE CRISP post processor calculates this normal stress using Mohr's circle stress transformation.

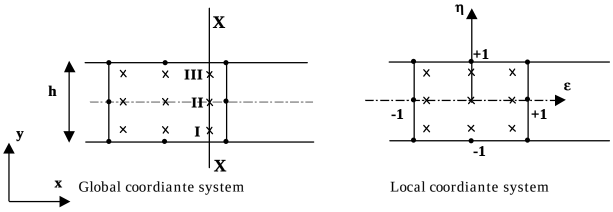


Figure 1 - An 8-noded quadrilateral element forming part of a beam

For reasons associated with numerical integration, it is convenient to work with a 'normalised' local coordinate system based on the following relationship

$$\frac{dy}{d\eta} = \frac{h}{2}$$

This leads to

$$y = \frac{h}{2}\eta$$

Using the local co-ordinates, we obtain

$$M_{xx} = \int_{-1}^{+1} \sigma_x \left(\frac{h^2}{4}\right)\eta.d\eta$$

The above integral can be evaluated using a three-point-one- dimensional Gauss integration rule. Thus:

$$M_{xx} = \left(\frac{h^2}{4}\right)\sum_{i=1}^{3} \sigma_{xi} \times \eta_i \times w_i$$

The co-ordinates and weights for the three Gauss points are:

Gauss point	η Coordinate	Weight
I	$-\sqrt{3/5}$	5/9
II	0	8/9
III	$\sqrt{3/5}$	5/9

Table 1

Substituting in the above integral, we obtain:

$$M_{xx} = \frac{h^2}{4}\left[\sigma_{x.I} \times (-\sqrt{3/5}) \times \frac{5}{9} + \sigma_{x.II} \times 0 + \sigma_{x.III} \times (\sqrt{3/5}) \times \frac{5}{9}\right]$$

Hence,

$$\boxed{M_{xx} = 0.1076 \times h^2 \left[-\sigma_{x.I} + \sigma_{x.III}\right]}$$

The following points must be born in mind when seeking bending moments from quadrilateral elements:

- When using non consolidation elements to represent a beam, the elements must be drained, i.e Kw = 0. Bending moments are calculated from effective stresses. Using an undrained material (with Kw being set to a large value) would produce reduced effective stresses, giving erroneous bending moments.
- It is important to use finer elements near the fixed end(s). This will allow more accurate calculation of stresses from which bending moments are obtained.
- It is important to specify the correct boundary conditions if you wish to obtain bending moments which are compatible with those from beam theory. When attempting to model a fully fixed beam, or cantilever, the user must ensure that the nodes forming the fixed edge (including mid side) are fixed in the x and y direction.

The examples below show a simple 10 m beam fully fixed at both ends with a point load of 1000 KN in the centre. It can be seen from Table 2 that both methods give very good correlation to the beam theory calculations.

Figure 2 - Non Consolidation quadrilateral elements

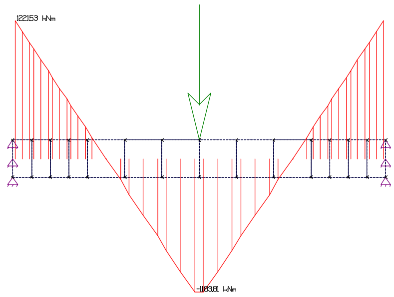
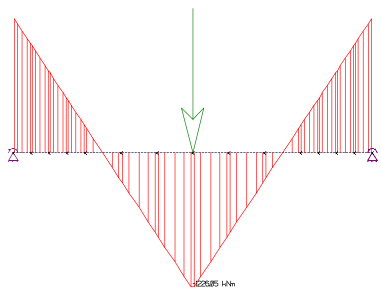


Figure 3 - Beam elements



Method	Central BM	End BM
Theory	-1250	1250
Beam elements	-1226	1237
NC Quad elements	-1183	1225

[1]*Hinton & Owen (1977) - Finite element programming. Academic press.*

3D Analysis of Retaining Walls

David Richards Profiles the use of CRISP at the University of Southampton

Over the past few years the Geotechnics Research Group at Southampton University has made considerable use of SAGE CRISP for a variety of problems - mainly involving plane strain analyses. These include various embankment analyses, back analysis of centrifuge model tests investigating the effectiveness of earth berms, and the analysis of multi-propped retaining walls. These analyses have obviously all benefited from the use of the enhanced pre- and post-processing capabilities of SAGE CRISP, which is allowing ever more complex geometries and construction sequences to be modelled and the output to be examined. However, recent work within the group has necessitated the use of 3-D analyses for which there are currently no pre- or post- processing capabilities within SAGE CRISP. This has involved a considerable amount of time and effort for even a relatively modest 3-D analysis.

The performance of embedded retaining walls is influenced by both the in-situ stress state of the ground and by the stress changes during the installation of the wall and subsequent construction. The installation sequence of a diaphragm wall panel in the ground (involving excavation under bentonite slurry followed by the placement and hardening of concrete) is an extremely complex 3-D problem which cannot be analysed adequately in 2-D. If numerical analyses are to predict realistic wall and ground movements, the mechanisms of load transfer which operate during wall installation and which subsequently affect post- installation behaviour must be adequately represented.

> ***"Early results from the CRISP analyses show very good agreement between the observed and computed behaviour of the props and wall movements."***

An EPSRC CASE award has given us the opportunity to use CRISP in a 3D back analysis of a retained section of the A4-A46 Batheaston to Swainswick bypass in Avon. Initially, this involved modelling the wall installation process to determine the stress state needed for input into an analysis with the wall already in place. Subsequent analyses have investigated the phased removal of earth berms used as temporary support, and the influence of panel length on the short term stability of the wall until a permanent prop was installed. Comparison between idealised 2-D and the 3-D analyses indicate considerable benefits in undertaking 3-D analyses.

Within the group there is currently an EPSRC research grant to monitor continuously the temporary prop load development during the construction of a deep underground car park in the London clay at Achilles Way, W1. Of particular interest is the development of the load in the corner props since the use of these props may not be straightforward. This may be due to the prop loads needing to be distributed along the walling supports to which props are typically attached, and may involve the use of shear connectors. To analyse this particular problem for comparison with observed performance has required a 3D analysis. Using an elastic-perfectly plastic soil model, the analysis (which starts with the wall already in place) models the initial excavation of the top 1m of soil, the installation of the props, continued excavation to formation level, followed by the installation of the slabs. The analysis makes use of the two axes of symmetry which exist in order to limit the number of elements needed, but it still requires 1003 3-D quadrilateral consolidation elements. The analysis uses 64 increments which takes approximately 3 days to complete on a Pentium 133 MHz machine.

The output from the CRISP analysis is currently processed using FEMGEN/FEMVIEW which requires a translation file to be created and used with a CRISP/FEMGV interface program. Early results from the analyses show very good agreement between the observed and computed behaviour of the props and wall movements. Further work will investigate the influence of the wall corner stiffness/ construction detail on the development of prop loads.

In the two areas of research described above, the use of CRISP for 3-D analysis has presented a number of difficulties. Firstly, the main program (CRISPDMP) had to be amended to increase the size of an array allocation associated with "d- lambda" negative. This is directly related to the increased number of elements associated with 3-D analyses. There have also been considerable difficulties arising from the restricted number of element shapes available. This will no doubt be rectified over time as additional 3-D elements are added to the element library. However, the main difficulty has been mesh generation and data input together with post processing. This has been rectified to some extent by the use of FEMGV which incorporates FEMGEN (mesh generator) and FEMVIEW (post processor). However, the use of FEMGV requires a CRISP/FEMGV interface program, which has needed various modifications to make it work successfully, although some manual data input is still required to produce working MPD and GPD files. And what about the considerably increased times required to undertake an analysis? Well, 3-4 days for an analysis is a lot of computational time and some argue that this is, at present, the preserve of academic institutions only. However, computational time is becoming less expensive (and with parallel processing etc. will become much faster) and the increased accuracy of predictions of soil/structure behaviour using 3-D modelling is such that considerably less conservative designs could be achieved with greater cost savings as a result.

David Richards
University of Southampton
djr@soton.ac.uk

CRISP's journey continues ….

From Pusan … To Pretoria

I first came across the CRISP program in 1991 whilst staying at the University of Surrey as a visiting scholar. Subsequently, I have used CRISP as a tool for my research and consulting work. In 1996 I attended the Cambridge SAGE CRISP Course, and began to think about staging a similar course in Korea. I was finally able to achieve this in June of this year, when Rick Woods and Roger Chandler came to hold a 3-day course at Dong-A University.

Initially, I anticipated that there would be no more than 50 delegates for the Korean course, and so I prepared a lecture room and Pentium computing facilities accordingly. However, I soon had to book bigger rooms because many people wanted to attend, and ultimately I had to limit the number to 77!

Course evaluations from the delegates were extremely favourable, and 89% said that they would recommend the course to others. I hope we can run a further course next year, including more on applications of CSSM, and case studies based on Korean projects.

I would like to express my thanks to Rick and Roger for their generous help in running the course, and also to my students for their tremendous assistance.

Sung-Gyo Chung
Dong-A University, Pusan

The Department of Civil engineering hosted a three-day short course in July on Numerical Analysis in Geotechnical Engineering at the University of Pretoria in collaboration with LGI Center for Continuing Education.

Numerical methods have long been established amongst European engineers but have only recently grown in popularity in South Africa. There was therefore a strong need for a course such as this, to introduce the subject and to inform delegates of the uses (and abuses) of these methods.

Roger Chandler and Mike Gunn came over from the UK to give lectures, with local input provided by Nico Vermeulen and Eben Rust . The course attracted 30 delegates, comprising full-time postgraduate students and representatives from industry. Feedback has been very positive and some of the delegates have already invested in a copy of SAGE CRISP.

The University of Pretoria has an academic licence for SAGE CRISP and will be using it for teaching and research in the future. I would like to take this opportunity to thank both the CRISP Consortium and SAGE Engineering for all their help.

Nico Vermeulen
University of Pretoria

Korean User Group Launched

Following the recent successful course in Korea, and the growing number of CRISP users in that country, we are pleased to announce that Professor Sung-Gyo Chung, from Dong-A University in Pusan, has become chairman of the first overseas CRISP Users Group. For further information contact Professor Sung-Gyo Chung by fax on (82) 51 200 7625.

It is our expectation that this will lead to the establishment of other Groups around the Pacific rim, where SAGE CRISP has been very well received over the past 2 years.

We would be pleased to here from anyone who is considering starting a User Group in their part of the world.

The CRISP Consortium

Dairy Dates

September 16th-19th
Advanced Geotechnical Analysis
using SAGE CRISP, ETH, Zurich
Contact: Claire Derbyshire
Fax: (44) 1223 302233
Email: CPI@hermes.cam.ac.uk

September 26th
10th CRISP User Group Meeting
City University, London
Tel: (44) 171 477 8147,
E-mail: s.e.stallebrass@city.ac.uk

November 17th - 18th (to be confirmed)
Advanced Geotechnical Analysis
using SAGE CRISP,
National University of Singapore
Contact: Anurag Mathur
Fax: (65) 221 9928
Email: qedes@singnet.com.sg